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doi:10.1093/bja/aev231

Anaesthesia for preterm Caesarean delivery: is it different from term deliveries?

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Worldwide, more than 15 million babies are born annually preterm (fewer than 37 completed weeks’ gestational age), approximately one in 10 births.1 In England and Wales, 7% of births are preterm,2 and in the USA, more than 11%.3 Prematurity is the leading cause of newborn death, and survivors may face lifelong disability.1 Preterm birth may result from the preterm onset of spontaneous labour or from obstetric intervention for maternal or fetal indications, when the risk of preterm birth is deemed to be lower than the risk to the mother or fetus of continuing the pregnancy.

The optimal mode of delivery for preterm fetuses, especially very early preterm, is a matter of much discussion in the obstetric community. Except for specific indications (e.g. breech presentation), evidence is lacking that Caesarean delivery results in better neonatal outcomes than vaginal delivery. However, a larger proportion of preterm infants are born by Caesarean than term infants. In the USA in 2013, 46.6% of preterm fetuses were delivered by Caesarean.4 The mothers of these infants require surgical anaesthesia for delivery, either general or neuraxial, and by extension, the preterm fetus will be exposed to the adverse (or beneficial) effects of these techniques.

There is little evidence that mode of anaesthesia impacts outcomes for term infants.5 It is conceivable, however, that the mode of delivery anaesthesia might influence outcomes for these tiniest of humans. It is generally believed that the preterm fetus is more susceptible to the depressant effects of anaesthetic drugs than the term fetus;6 thus, one might hypothesize that neuraxial anaesthesia is preferable for preterm deliveries. However, delivery is often urgent in these patients, and the induction of general anaesthesia is faster than neuraxial anaesthesia. An understanding of the patterns of use of anaesthesia in this population might be a helpful first step in determining whether the mode of anaesthesia plays a role in outcome.

In this issue of the British Journal of Anaesthesia, Butwick and colleagues6 report a secondary analysis of data from the United States National Institutes of Child Health and Human Development Maternal–Fetal Medicine Units Network Cesarean Registry. Data were collected prospectively between 1999 and 2002 from 19 US academic medical centres. All women with a Caesarean delivery were included in the first 2 yr of the Registry, and only women with previous Caesarean delivery were included in the last 2 yr.

The aim of the study by Butwick and colleagues6 was to identify risk factors for general anaesthesia in a population of women undergoing preterm Caesarean delivery. Potential risk factors included maternal age, predelivery body mass index, race or ethnicity, gestational age, singleton or multiple gestation, primary or repeat Caesarean delivery, fetal presentation at delivery, and the presence of hypertensive disorders of pregnancy, labour, premature preterm rupture of membranes, and emergency indication for delivery. Overall, 82.4% of women received neuraxial anaesthesia and 17.6% received general anaesthesia. This distribution is significantly different from the distribution reported for the entire Registry (93% received neuraxial anaesthesia).7 Thus, it appears that preterm infants were at higher risk for exposure to general anaesthesia than term infants.

In the final multivariate model of the study, race or ethnicity, haemolysis, and elevated liver enzymes and low platelet (HELLP) syndrome or eclampsia (combined) were independently
associated with receiving general anaesthesia for preterm Caesarean delivery.

The odds for general anaesthesia were higher with emergency compared with non-emergency delivery (but not the ‘highest odds of general anaesthesia’ as stated in the abstract; this was not tested). Although the investigators stated that the rate of general anaesthesia was higher than the rate of neuraxial anaesthesia for each indication for emergency Caesarean delivery, this was not true. In fact, the rate of neuraxial anaesthesia was greater than that of general anaesthesia for three of the four indications for emergency delivery (placental abruption, placenta praevia with antenatal haemorrhage, and non-reassuring fetal trace). Only for umbilical cord prolapse was the rate of general anaesthesia (71.4%) greater than the rate of neuraxial anaesthesia (28.6%).

Of course, it makes sense that the rate of general anaesthesia is higher for emergency compared with non-emergency indications. This is true for both term and preterm deliveries. Women with HELLP syndrome are likely to have received general anaesthesia because of possible increased risk of epidural–spinal haematoma associated with a neuraxial technique. Why general anaesthesia was related to race or ethnicity and inversely related to gestational age is less clear and requires further investigation.

The authors have listed a number of limitations to their study design and results. An important limitation is the age of the data. Both obstetric and anaesthesia practices have changed in the past 16 yr. Another important limitation is the lack of a hospital identifier in the database. Thus, the investigators were not able to control for hospital-level factors that may influence anaesthetic practice. Repeat Caesarean deliveries may be over-represented in the database because inclusion criteria changed in the middle of the original study. Finally, as in all observational studies, causality cannot be determined. Important confounding variables may be missing.

Data regarding optimal anaesthesia management for preterm delivery are scarce; Butwick and colleagues6 should be commended for adding a small piece to the puzzle. However, the most important clinical question remains to be answered. Does anaesthesia technique influence neonatal outcome, and if so, how? Preterm infants have less protein for binding drugs, higher concentrations of bilirubin, which competes for protein binding of drugs, an immature blood–brain barrier, and decreased ability to metabolize drugs. How these changes influence the fetal response to maternal anaesthesia, however, is unclear. Of concern are recent data in rodent and non-human primate models demonstrating long-term effects on fetuses exposed to anaesthetic agents (γ-aminobutyric acid receptor agonists and N-methyl-D-aspartate receptor antagonists) during periods of central nervous system synaptogenesis.8 In humans, this period starts in the second trimester. However, the duration of anaesthetic exposure in these animal models far exceeds that of human fetal exposure during general anaesthesia for emergency Caesarean delivery. The human implications are unknown, including whether timing of exposure is important. An additional concern is fetal exposure to high concentrations of oxygen. This is necessary for the safety of the mother during the induction of general anaesthesia, but has been shown to result in an increase in oxygen free radical activity in fetuses.3 Again, the clinical implications are unknown, but are of particular concern in asphyxiated infants, who may sustain reperfusion injury.

Concerns also exist regarding the safety of spinal anaesthesia. The French EPiPAGE study (Etude épidémiologique sur les Petits Ages Gestationnels) was a prospective cohort study that included infants born between 27 and 32 weeks’ gestation in nine French regions in 1997. A secondary analysis of 1338 infants delivered by Caesarean, published in 2009, identified a higher rate of neonatal mortality in infants whose mothers received spinal anaesthesia (12.2%) compared with epidural anaesthesia (7.7%) and general anaesthesia (10.1%).10 The higher odds of death associated with spinal anaesthesia remained after adjustment for confounding risk factors. However, these data are now almost two decades old. The practice of spinal anaesthesia has changed significantly during this interval, including a greater appreciation for the need to maintain maternal blood pressure near baseline. Again, the data may be confounded by unidentified variables.

Finally, in a single-centre retrospective study (1986–1991) of 509 preterm infants at gestational age 32 weeks’ or less, 1 and 5 min Apgar scores were lower in infants exposed to general compared with epidural anaesthesia.11 Umbilical cord blood gases and other long-term outcomes were not assessed. Again, it is possible that selection bias played a role in these results; women who were stable had time to receive epidural analgesia and anaesthesia, whereas those who were unstable (mother or fetus) did not.

The general practice in the Western world is to induce neuraxial anaesthesia for most women undergoing Caesarean delivery, unless it is contraindicated by maternal disease or because of the emergency nature of the procedure. Taken together, the limited data of Butwick and colleagues6 do not suggest that this practice should be altered because the fetus is preterm. However, their study should serve as a reminder that the data really are very limited, and further study is required. A significant proportion of our population is born preterm, and a significant proportion of these preterm infants are delivered by Caesarean. Thus, it is imperative that further research determine whether anaesthesia technique contributes, positively or negatively, to the outcome of these fragile humans.

Declaration of interest

None declared.

Funding

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References

Ventilation through a ‘straw’: the final answer in a totally closed upper airway?

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In the rare situation of ‘cannot intubate, cannot ventilate’ (CICV), even very experienced anaesthetists find it challenging to avert a potentially life-threatening situation. In this situation, all techniques routinely used in daily clinical practice, such as bag mask ventilation, placement of a laryngeal mask, and laryngoscopy, may fail to oxygenate and ventilate the patient. In most instances, the patient already presents with severe hypoxia and is very close to or even has experienced cardiac arrest. The anaesthetist is then forced to take measures that most doctors prefer to avoid. In this life-threatening situation, guidelines throughout the world recommend a surgical cricothyroidotomy as the only remaining option to (re-)oxygenate the patient. The problem with these techniques is lack of specific training and the fact that the techniques are not routinely used. It is possible, therefore, that the anaesthetist opens the ‘cric set’ for the first time and is confronted with instruments that he or she has never used before in a real emergency.

Occasionally, appropriate equipment might not even be available immediately. Simple ‘tricks’ using self-made or self-assembled tools could be and are often used, but have mostly been proved to be insufficient or even inherently dangerous. For example, puncture of the cricothyroid ligament with a standard large-bore i.v. cannula with attachment of a self-inflating resuscitation bag using a self-assembled connector (e.g. the cylinder of a 2 ml syringe with a 5 mm tube connector plugged in) has been shown to be ineffective to achieve ventilation and oxygenation. Three-way taps proposed for emergency jet ventilation do not provide sufficient control or release of oxygen flow and pressure to the patient, so in the event of complete upper airway obstruction the intrathoracic pressure can unintentionally increase more than 70 cm H₂O. Most physicians, especially those working in less ‘invasive’ specialties like anaesthesiology, have difficulties imagining ‘to cut with a blade in someone’s throat and slit the trachea open’. Unfortunately, a patient in need of a cricothyroidotomy may often also have abnormal neck anatomy, so that access to the airway might become very difficult with any technique. The combination of a rare event, lack of training and routine, insufficient equipment, challenging anatomy, and reluctance to apply a (very) invasive technique results in a high failure rate of cricothyroidotomy.

Although they are familiar with puncturing techniques and procedures (e.g. placement of central venous lines), most anaesthetists still find the idea of puncturing the trachea more appealing than performing a surgical cricothyroidotomy in the event of a CICV emergency. Additionally, puncturing the cricothyroid ligament and injecting local anaesthetics into the trachea for topical anaesthesia is routinely used in anaesthesia before an awake flexible fiberoptic intubation. In fact, this so-called ‘cricothyroid stab’ helps to train identification of the anatomical structures and to improve individual performance in routine situations without stress.

Using a standard i.v. cannula for a cricothyroidotomy has clear limitations, because the cannula may kink as a result of the material from which the product is made, such that it may become soft and flexible after insertion. In addition, any manipulation can easily lead to inadvertent dislodging of the cannula. Therefore, the current guideline of the Difficult Airway Society clearly indicates the technical demands for cannula (needle) cricothyroidotomy: a kink-resistant cannula is required along with a dedicated high-pressure ventilation system to overcome the flow resistance of the cannula. Transtracheal jet ventilation refers to injection of oxygen at high pressure and high velocity through a laryngeal or tracheally placed cannula. There are several devices currently available commercially.

For adequate expiration, a sufficiently patent upper airway is mandatory to avoid critical complications such as barotrauma and haemodynamic deterioration caused by high intrathoracic or intrapulmonary pressures. Passive expiration via the translaryngeal or transtracheal cannula is very limited because of the high flow resistance of the relatively small lumen. In a CICV situation, however, the upper airway might be swollen as a result of desperate attempts to intubate and ventilate the patient. Furthermore, pathology of the upper airway, such as a pharyngeal...